Dr. Girdner's Telephonic Bullet Probe.

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ON THE DETECTING AND LOCATING OF METALLIC MASSES IN THE HUMAN BODY BY MEANS OF THE INDUCTION BALANCE AND THE TELEPHONIC PROBE.

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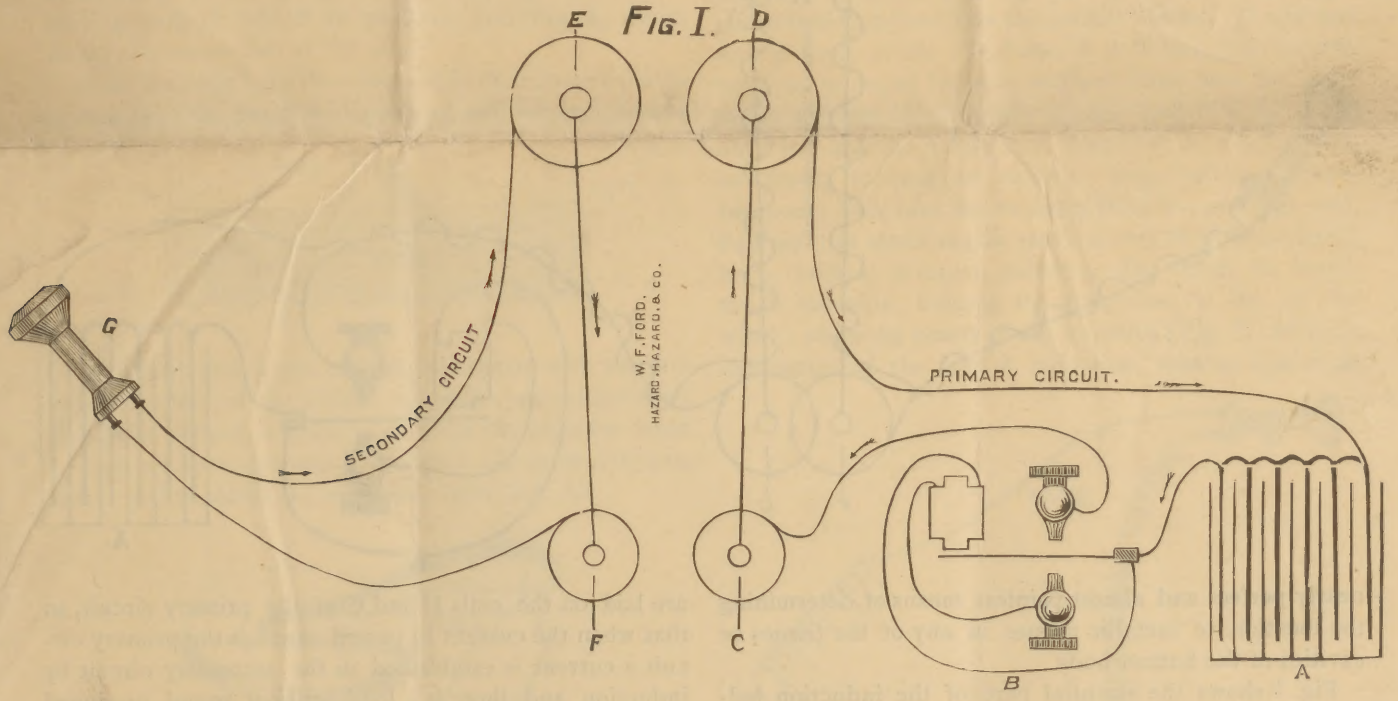
MY purpose in this paper is to describe the induction balance and the telephonic probe, two apparatuses which are to aid the surgeon in determining, in a painless manner, the precise spot at which a leaden bullet is located, or any other metallic substance which may have found a lodgment in the tissues or cavities of the human body. The principle of induction in electricity is so well understood that any account of it in an article of this kind would be out of place; therefore I shall confine my remarks to the application of it to purposes of surgical diagnosis. In the Summer of 1881, during the anxious days of the last illness of the late President Garfield, and when the surgeons in attendance had failed by every means at their command to locate the assassin's bullet in his body, it occurred to Professor Alexander Graham Bell, of Washington, D. C, the well-known electrician and inventor, that, with perfectly balanced induction coils, having a telephone receiver in the secondary circuit, he might be able to determine the location of the bullet by an audible sound which would be produced in the telephone when the balance was disturbed by the exploring coils being brought to a point on the surface of the body directly opposite to the bullet. Strangely enough, this same idea of using the induction balance occurred to Mr. George M. Hopkins, of Brooklyn, at about the same time, and independently of Professor Bell. Professor Bell at once constructed an apparatus and took it to the White House, and made the experiment on the person of the President, but failed to find the bullet, owing to the crude character of the apparatus thus hurriedly constructed, together with lack of experience in its use, and also to the disturbing influence on the bal-

FIG. I.



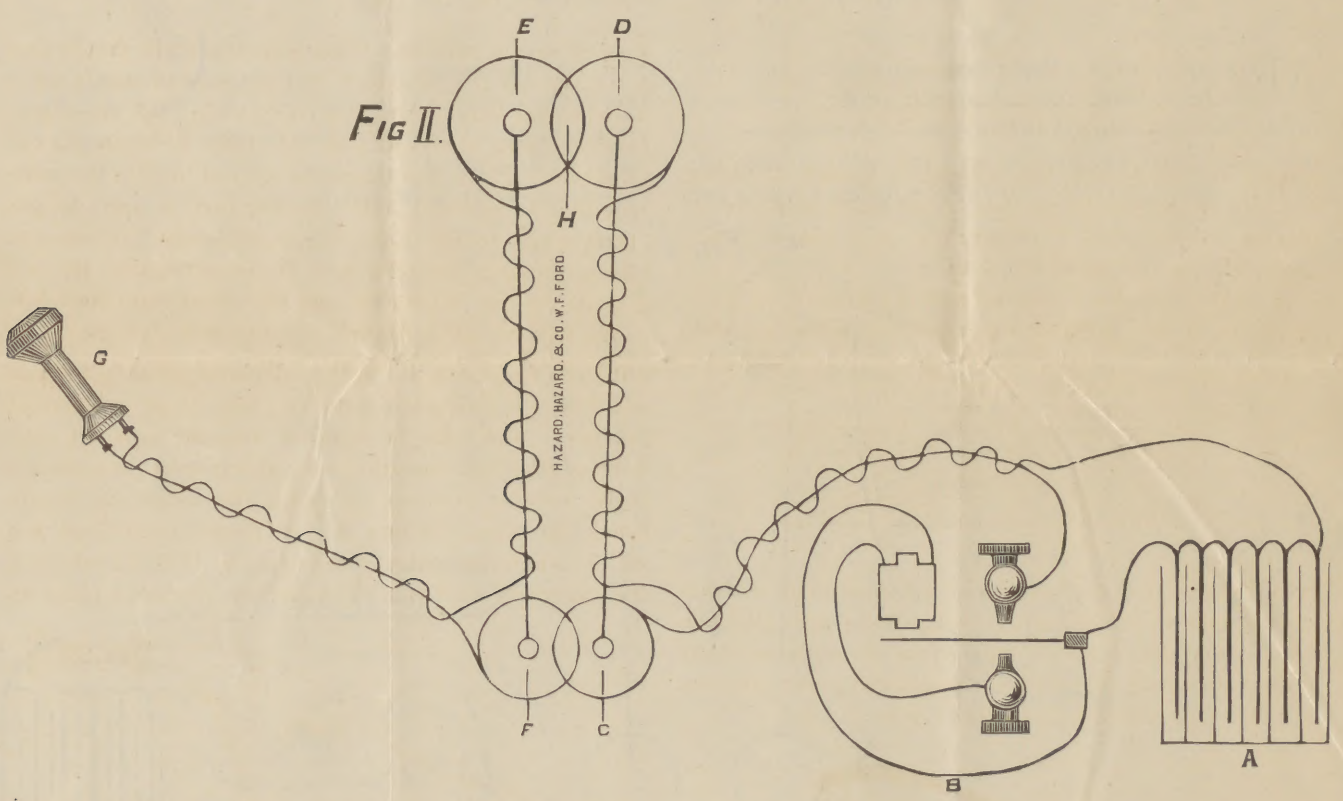
ance of a steel mattress under the hair one on which the President lay, and the presence of which was unknown to the experimenters at the time.

No other attempt was made to find the bullet in the President's case, as Professor Bell was unavoidably kept from further experiment at that time ; hence the location of the bullet remained unknown until the autopsy at Elberon revealed it.

It would, doubtless, be of interest to follow the subsequent history of the development of this apparatus to its present state, but I shall content myself by saying that Professor Bell has now placed at our disposal a highly practical apparatus, which, used in connection with his other invention—which I have ventured to name the *telephonic probe*, and will describe further on—gives us a nearly perfect and almost painless means of determining the location of metallic masses in any of the tissues or cavities of the human body.

Fig. 1 shows the essential parts of the induction balance. At A is an ordinary bichromate-of-potassium battery of six cells; a greater or less number of cells can be used, but the best results will, I think, be obtained when six freshly filled cells are used. At B is shown a rheotome ; as an interrupted and not a continuous current is required, five or six hundred interruptions per second should be had. At C is a small coil of about No. 25 copper wire, thoroughly insulated. This coil is about one inch in diameter by half an inch in thickness, and the spool on which the wire is wrapped is of hard rubber. At D is another coil of fine insulated copper wire, about three inches and a half in diameter by three quarters of an inch thick, and the spool on which the wire is wrapped is of card-board. These two coils, together with the rheotome and battery, it will be seen, are connected by wires, forming a complete circuit, marked *primary circuit*. At E and F are coils precisely similar to those shown at D and C, and at G is a telephone receiver. The coils E and F, with the telephone receiver, it will be seen, are connected by wires, and form a complete circuit, marked *secondary circuit*. It will also be observed that the course of the currents in the two circuits is in opposite directions, as indicated by the arrow-heads.

Fig. 2 represents the same parts as Fig. 1, except that in the latter cut the apparatus is shown in position for work—that is, the coils E and F of the secondary circuit



are laid on the coils D and C of the primary circuit, so that when the current is passed through the primary circuit a current is established in the secondary circuit by induction, and there is a loud musical sound produced in the telephone receiver at G. Now, if the coil F be moved about on the surface of the coil C, a position will be found for it in which there is a perfect balance established between the two currents, and consequent silence in the telephone.

With this balance established, if any metallic substance be brought near to the point marked H, which is the centre of the *induction area*, the balance is disturbed and the telephone gives forth a high-pitched musical sound which increases or diminishes as the metal approaches or recedes from the point H. Now, it is evident that to

make this apparatus available as a means of surgical diagnosis, we must arrange to bring the point H in the neighborhood of the metallic mass, and thus have a means of exploring the whole surface of the body in which we suspect a bullet to be lodged. In order to do this, the two coils, E and D, which we will call the exploring coils, are let into a turned-out space in a block of wood and held in position by melted paraffin being

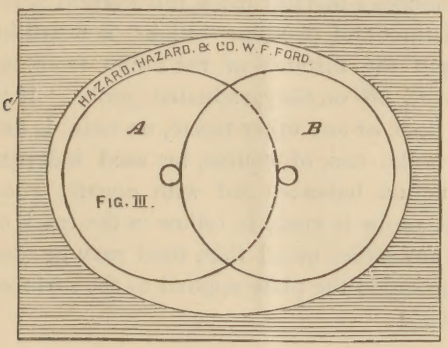


FIG. III.

poured over them and then allowed to harden, as in Fig. 3, which shows the flat surface of the block with the exploring coils A and B in position, and Fig. 4, which shows a cross-section of the same.

After the coils have been secured in their proper places by means of the paraffine, a piece of silk velvet is pasted

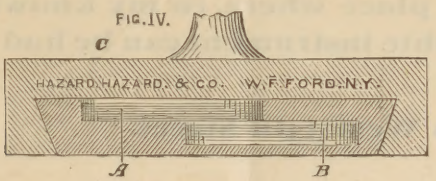


FIG. IV.

over them to give a soft surface for contact with the skin in explorations of the body. A handle is next glued on the upper surface, and the wires from the coils are made to pass out along grooves in its upper and lower surfaces, and it is thus called the explorer. (See Fig. 5.)

FIG. V.

The coils F and C, Fig. 2, are called the adjusting coils, and are also attached to a block of wood and arranged with a delicate screw adjustment for moving one upon the other, thus enabling us to obtain a perfect balance between the two circuits and perfect silence in the telephone. Fig. 6 shows this screw adjustment.

To use the apparatus, place the patient on a table with the parts exposed in which the bullet is supposed to be located, place the table in the middle of the room, and have *both patient and table entirely free from any metallic substance;* or, if this is not possible, as nails are used in most tables, be certain you know where each nail is located. Remove all metal from the operator so far as is possible, and know where each piece which remains is located, so that allowance can be made if it exerts a disturbing in-

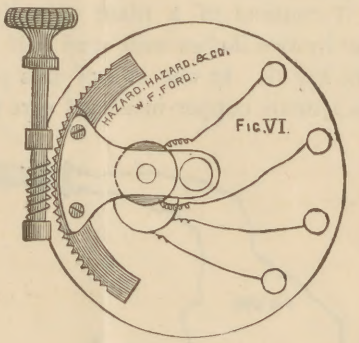


FIG. VI.

fluence on the balance. The patient's teeth should also be examined for fillings, if you propose to search for a bullet in the neighborhood of the cheek. All these precautions being observed, you are ready to begin the exploration. Place the telephone to your ear at the same time that an assistant holds the explorer at arm's length about twelve inches from the patient's body. If now you hear a noise in the telephone, it indicates that the two circuits are out of balance, and you must turn the screw in the adjuster (Fig. 6), first one way and then the other, until you find the noise in the telephone growing weaker, and finally it disappears entirely; then there is a perfect balance. Now take the explorer from the assistant, and, holding it at arm's length, pass it slowly over the patient's body, *without pressure*, allowing the velvet to barely touch the skin, holding the telephone to the ear the while; when the centre of the explorer (Fig. 5), which is the centre of the area of induction, reaches a point on

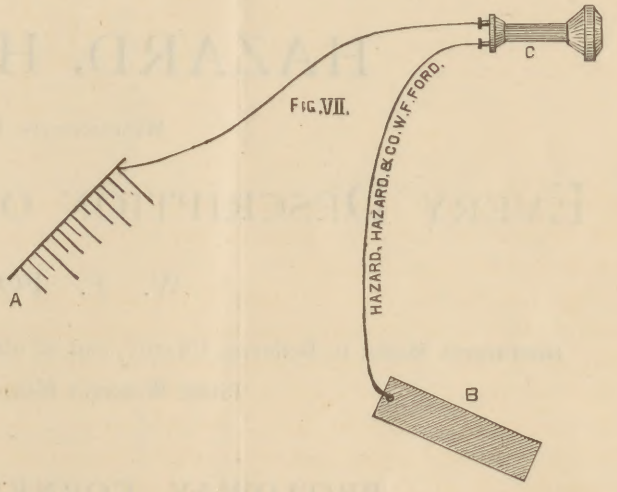


FIG. VII.

the skin directly opposite the bullet in the body, the telephone announces it by a musical sound, and, as you approach or recede from this point on the skin with the centre of the explorer, the sound in the telephone increases or diminishes. This point on the skin should be

marked, and we know certainly that if a needle is passed directly in at this point at right angles to the skin, it will come in contact with the missile.

We come now to the second apparatus mentioned—viz., the *telephonic probe*, another of Professor Bell's inventions. It consists of a plate of polished steel six inches long by two inches wide and half an inch thick, shown at B, Fig. 7. In one end of this plate is a hole from which a small copper-insulated wire leads to a tele-

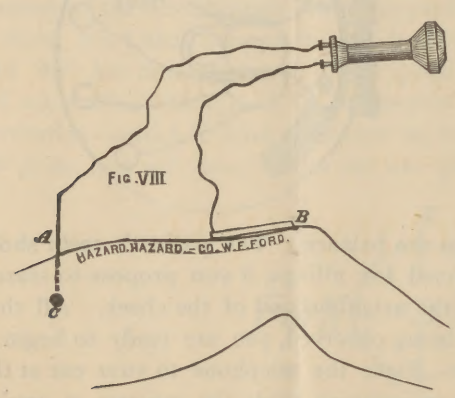


FIG. VIII

phone receiver, C. At A is a finely tempered steel needle of suitable length, which may be for convenience graduated in inches and parts of an inch ; from the eye of this needle a second wire leads to the other pole of the telephone receiver, C. The manner of using this apparatus is shown in Fig. 8. The point on the surface opposite the bullet having been determined by the induction balance, as described above and shown at A, Fig. 8, the operator moistens the skin with vinegar at a convenient point, as at B, and lays the steel plate on this moistened surface, and, while an assistant presses it firmly against the skin, he places the telephone receiver to his ear, and with the other hand thrusts the steel needle into the tissues at right angles to the surface. The body now acts as a battery, with the steel plate and the needle forming the two poles, and a feeble, continuous electric current passes through the circuit thus formed ; but when the needle touches a metallic mass, this current is interrupted and a distinct and peculiar "click" is heard in the telephone, and the distance of the bullet from the surface can be read off on the graduated probe. If the needle touches bone or any other tissue, no noise is heard.

This probe can, of course, be used independently of the induction balance, and with equally good results, when the probe is made to follow in the track of the bullet, and any other metal than steel may be used for the probe, provided the plate applied to the surface be of the same metal.

I desire to express my thanks to Mr. W. F. Ford, of Hazard, Hazard & Co., for the cuts used in this article.

They are prepared to manufacture these apparatuses, and theirs is the only place where, to my knowledge, a reliable instrument can be had at present.

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